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ABSTRACT

In response to the need for improved mathematics and science education for all students, the Southeastern Regional Vision for Education (SERVE) states have enacted policy initiatives to raise graduation requirements; increase standards for teacher preparation; revise state curriculum guides and frameworks; and develop statewide student assessments. This study examined the effects of these efforts on students' enrollment in advanced classes; mathematics and science achievement; and enrollment and achievement differences by racial/ethnic group and sex. A comparison of course enrollment data indicated that while student enrollment in mathematics and science courses has increased since 1982, less than half of those enrolled were taking upper level courses. Results of the 1990 National Assessment of Educational Progress indicated an upward trend in mathematics and science performance among 9- and 13-year-olds, while 17-year old students performance followed the national pattern. Trends in Academic Progress data indicate an improvement in achievement and enrollment levels of African-American and Hispanic students, but also indicate that differences still exist. Recommendations for reform initiatives are given for teacher training, educational resources, instructional methods, curriculum reform, and enrollment of all students in higher level courses. (MDH)

SERVE

Policy Brief

The Need for Improved Mathematics and Science Education

March 1993

ED359071

A number of recent reports have emphasized the critical need for a population that is scientifically, mathematically, and technologically literate. The National Science Board stated that

> **By 1995, the Nation must provide, for all its youth, a level of mathematics, science, and technology education that is the finest in the world, without sacrificing the American birthright of personal choice, equity, and opportunity" (Educating Americans for the 21st Century, 1983).**

In addition, the National Education Goals state that, by the end of this decade,

> **U.S. students will be first in the world in science and mathematics achievement.**

The imperative for schools is clear. The need exists for improved science and mathematics education for all students. "The components–social, economic, instructional, and political–that contribute to effective . . . learning are massive in number" (*The STATE of Mathematics Achievement*, 1991, p. 5).

In response to these needs, and in an attempt to address these instructional components, the SERVE states have enacted policy initiatives designed to improve mathematics and science education. They have raised graduation requirements (see Chart 1) and increased standards for teacher preparation.

In addition, SERVE states have revised state curriculum guides and frameworks (see Chart 2 at right) and are developing new statewide student assessments.

CHART 1
Graduation Requirements

State	CREDITS Math	Science	Effective Date
Alabama	4	4	1996
Florida	3	3	Current
Georgia	3	3	1997
Mississippi	3	2	1995
North Carolina	3	3	1996
South Carolina	3	2	Current

Sources: State Departments of Education

CHART 2
Curriculum Guides or Frameworks

Math	Grade Level	Effective Date
AL	K-12	1990
FL	6-12	1991
GA	K-12	1994
MS	K-12	1993
NC	K-8 9-12	1989 1992
SC	K-12	1992

Science	Grade Level	Effective Date
AL	K-12	1994
FL	6-12	1993
GA	K-12	1994
MS	K-12	1993
NC	K-12	1994
SC	K-12	1993

Sources: State Departments of Education

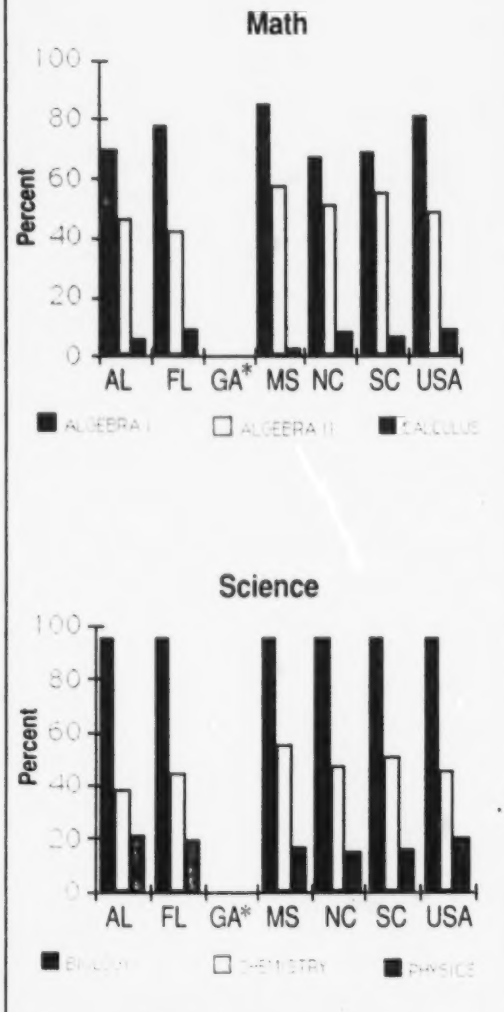
Expanded student assessment programs have provided extensive achievement data that highlight areas of increased student learning and areas still needing attention. Three questions are raised:

- Does increasing graduation requirements necessarily mean that students are taking more classes at advanced levels?
- How has achievement been affected?
- Are there enrollment and achievement differences by racial/ethnic group?

ARE STUDENTS TAKING ADVANCED CLASSES?

A comparison of course enrollment data, published by Blank and Engler in the Spring 1992 issue of Educational Research Service's *Spectrum*, indicated that mathematics and science enrollments increased at all levels from 1982 to 1990. The percent of students in the SERVE region who are enrolled in mathematics and science courses is given in Chart 3.

CHART 3
Percent Enrollment in High School Mathematics and Science Courses



Source: State Departments of Education

*Information not available.

However, a study by Blank and Dalkilic notes that, nationwide, 27 percent of students surveyed in 1989 "were taking a course at a level prior to Algebra I such as general mathematics, vocational/business mathematics, or pre-algebra" (1990). So, while students are enrolling in more mathematics and science courses, less than half are taking upper-level courses such as Algebra II or Chemistry. Enrollments for courses beyond Algebra II and Chemistry have risen very little.

Preparing students to take more advanced mathematics and science classes must become a system-wide effort. Revisions to existing curriculum frameworks in the SERVE states are designed to provide an earlier introduction to concepts such as statistics and probability and applying mathematics and science to everyday problems. Elementary teachers who spend more time teaching math and science are able to include more instruction on higher-level concepts. Information on the amount of instructional time spent on mathematics and science in elementary schools is presented below.

CHART 4
Elementary Class Time–Mathematics and Science

	MATH		SCIENCE	
State	**Grade 1-3** hours per week	**Grade 4-6** hours per week	**Grade 1-3** hours per week	**Grade 4-6** hours per week
AL	4.8	4.8	2.8	3.7
FL	4.9	4.9	2.6	3.2
GA	4.6	4.9	2.6	3.3
MS	5.2	6.0	2.8	2.4
NC	4.8	5.3	2.9	3.8
SC	5.0	5.1	2.4	3.4
National Median	**4.8**	**4.9**	**2.3**	**3.0**

Source: Blank and Dalkilic, 1990

With a few exceptions, SERVE states are at or exceeding the median for the amount of elementary mathematics and science instruction. However, it is interesting to note that "the median class time spent on English/language arts is 11.9 hours per week in grades 1 - 3 and 9.5 hours per week in grades 4 - 6" (Blank and Dalkilic, 1990). It is apparent that mathematics has not historically been given sufficient emphasis in the elementary grades. Science has received even less.

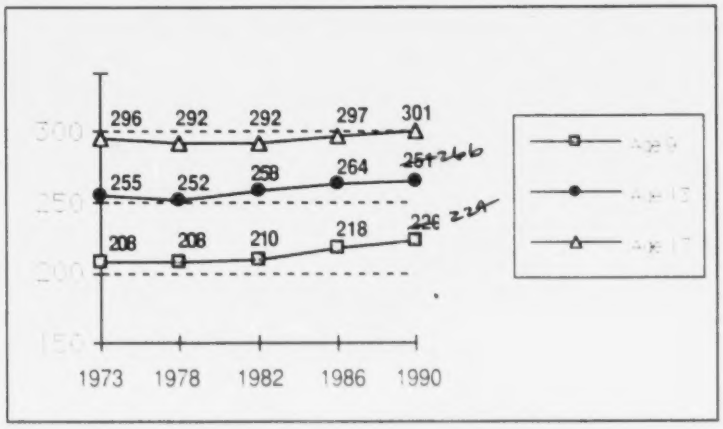
HOW IS ACHIEVEMENT BEING AFFECTED?

There is an encouraging trend in both mathematics and science achievement in the Southeast. In the 1990 National Assessment of Educational Progress (NAEP), both 9- and 13-year-olds showed significant improvement in performance in mathematics and science. For 17-year-olds, the regional pattern is very similar to the national pattern, which showed declines in performance during the 1970s, followed by improvement; 1990 scores were very similar to scores from the early 1970s (see Chart 5).

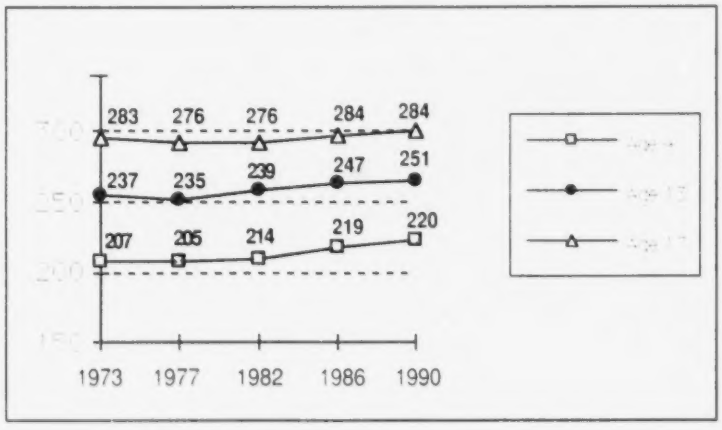
CHART 5

Trends in Average Proficiency (Southeast)

Mathematics



Science

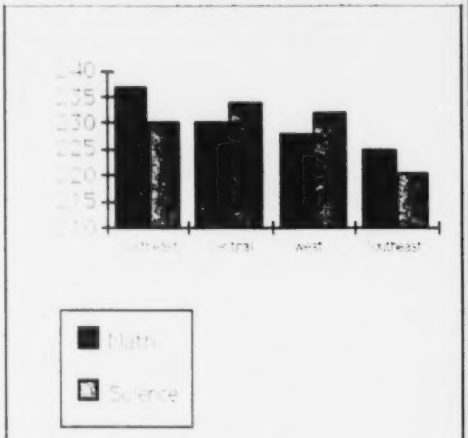


Source: *Trends in Academic Progress*, National Center for Education Statistics, 1991.

Despite gains, however, younger students in the Southeast lag behind the rest of the nation in mathematics and science achievement (see Chart 6):

CHART 6

Mathematics and Science Proficiency of 9-Year-Olds by Region



Source: *Trends in Academic Progress*, 1991.

Although achievement gaps are not as great for 13- and 17-year-olds, there is concern about how to educate younger students as they move through school. These students appear to have larger needs than those of students being taught currently. It should also be pointed out that the achievement scores are based on multiple choice questions which assess factual knowledge rather than higher-level problem solving and application skills, so the problem may be larger than it appears at first glance.

As part of its annual assessment in 1990, NAEP conducted a voluntary assessment of eighth-grade mathematics achievement. Four SERVE states, Alabama, Florida, Georgia, and North Carolina, participated in the testing program. One of the assessments included in the NAEP study involved overall average mathematics proficiency. Four levels of proficiency were described: Level 200 was material typically covered in third grade; 250 was material generally covered in fifth grade;

300 was material introduced by seventh grade; and 350 was high school material presented in preparation for advanced mathematics study. The achievement levels for the nation as a whole and for the four participating SERVE states are presented in Chart 7 at right.

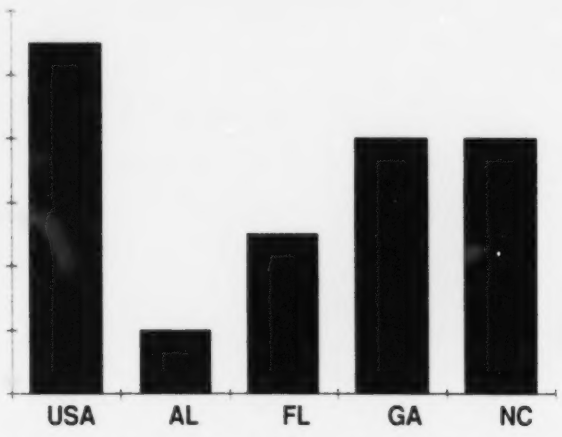
Despite trends that show overall improvement in students' average proficiency, some segments of our population continue to struggle with achievement gains.

ARE THERE ENROLLMENT AND ACHIEVEMENT DIFFERENCES BY RACIAL/ETHNIC GROUP?

Despite recent gains, it is apparent that a large segment of America's youth receives only limited access to quality mathematics and science instruction. Minority and female students have lower test scores in math and science; they are also underrepresented in these courses and, ultimately, in mathematics- and science-related careers.

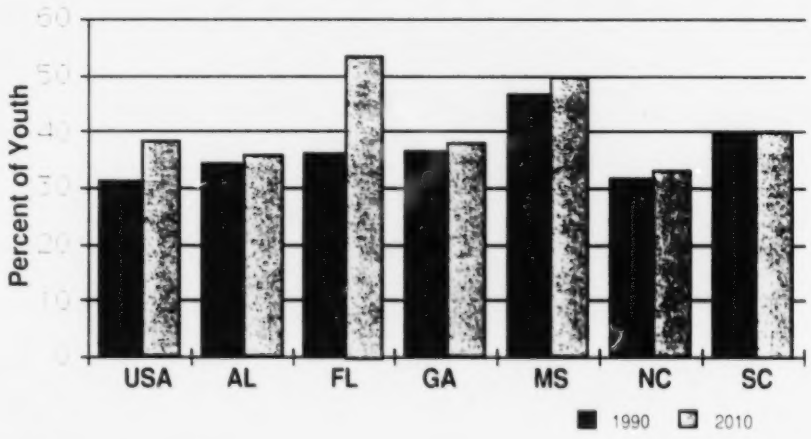
The need for concern about minority participation in these critical areas becomes apparent when we look at changing demographics, particularly in the SERVE states. According to the *Kids Count Data Book* (1992), 31.1 percent of America's youth population was minority in 1990. In the SERVE states, the percentages are even higher. By 2010, more than half of the Florida and Mississippi student populations will be composed of minorities (see Chart 8). If we are serious about being economically competitive, we must ensure that these students receive better mathematics and science instruction to enable them to participate constructively in tomorrow's job market.

CHART 7
8th Grade Average Mathematics Proficiency



Source: *The STATE of Mathematics Achievement*, NAEP 1991.

CHART 8
Projected Increase in Minority Youth Population Percentage, 1990-2010

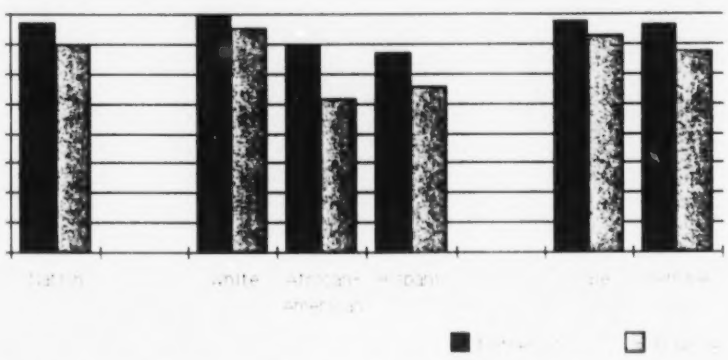


Source: Hodgkinson, 1992.

Findings by the National Center for Education Statistics underscore the "large differences in achievement and instructional contexts among some segments of our population, particularly African-American and Hispanic students and students attending schools in our disadvantaged urban areas, as compared to those attending schools in advantaged urban communities" (pp. 5-6). Charts 9 and 10 illustrate the differences nationally in achievement and enrollment among the groups mentioned.

CHART 9

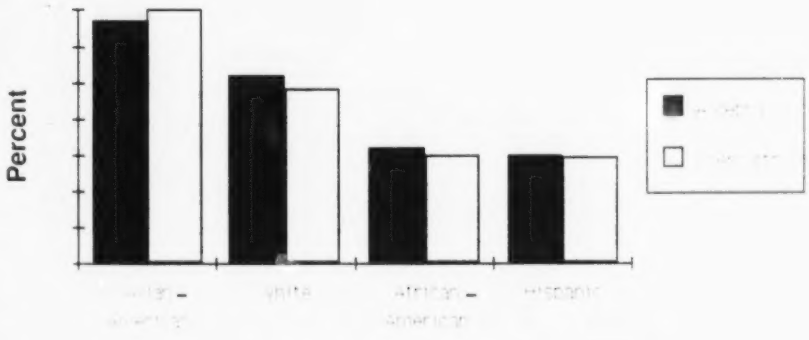
Average Proficiency in Science and Mathematics at Age 17 by Race/Ethnicity and Gender



Source: Trends in Academic Progress, National Center for Education Statistics, 1991.

CHART 10

Percentage Enrolled in Selected Courses



Source: Blank & Engler, 1992.

Trends since 1982 show an improvement in achievement levels of African-Americans and Hispanics, but much more progress is needed. We can no longer afford, ethically or economically, to continue practices which exclude segments of our society from reaching the highest levels of achievement and close off options early in their schooling.

WHAT CONCLUSIONS CAN WE DRAW?

In a guide to equity issues, DeAnna Banks Beane states

> The performance of U.S. students is of particular concern since mathematics and science have been identified as "the critical filters" for access to and success in mathematics- and science-related courses and careers. The development of this mathematics and science proficiency begins well before age 13. The importance of building foundations in elementary school science and mathematics courses for conceptual understanding, higher order thinking, and academic self-confidence must not be underestimated. Curricular and instructional practices which were used one hundred years ago do not adequately prepare students to be successful in a technologically-based society (1992, pp. 4-5).

As the United States competes in the world marketplace, its economic health—the prosperity of its citizens—depends increasingly on a work force that is literate in mathematics and science. Yet, American students rank near the bottom on international mathematics and science tests. And, in the SERVE states, where students lag behind the nation, the need is critical.

Recent initiatives provide hope that positive change will result from a unified effort by policymakers, business leaders, and educators. Changed attitudes and raised expectations mark the beginning of the work necessary to assure meaningful and lasting improvements. Policymakers

About SERVE . . .

SERVE–the SouthEastern Regional Vision for Education–is the educational improvement laboratory for the Southeast, operating under contract with the U.S. Department of Education. The lab serves Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. SERVE's goals are to address critical issues in the region, work as a catalyst for positive research and practice, and become an invaluable source of information for organizations working to promote systemic educational improvement.

For more information, please call the SERVE field office nearest you:

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can assist in efforts to continue the positive directions in a variety of ways. Reform initiatives should be designed to encourage schools to incorporate strategies for improvement including:

TRAINING

- Employing alternative teacher certification methods to attract talented mathematicians and scientists into teaching
- Improving staff development activities, including planned follow-up and sustained training

RESOURCES

- Using more technology resources, especially computers and calculators
- Increasing teaching tools such as mathematics and science labs equipped with manipulatives and high-interest computer software
- Continuing and expanding programs such as the National Science Foundation Statewide Systemic Initiative (NSF/SSI)
- Expanding distance learning to teach advanced courses in rural/urban schools

METHODS

- Providing more opportunities for small group and cooperative learning
- Emphasizing report writing and projects rather than rote drill and work sheets
- Decreasing reliance on multiple-choice assessments and moving toward open-ended items, hands-on exercises, and portfolios to allow skill in problem solving and application of knowledge to be demonstrated

CONTENT

- Emphasizing reasoning, higher-level problem solving, and applications of knowledge
- Building foundations for proficiency in elementary grades by including conceptual knowledge, higher-order thinking, and academic self-confidence

ENROLLMENT

- Encouraging more students to pursue study in mathematics and science
- Increasing the number of students enrolled in higher-level courses
- Addressing the growing racial and cultural diversity in schools

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SERVE's Mathematics and Science Consortium works to promote systemic reform in Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina. In collaboration with other stakeholders in the region, the federally funded consortium works to expand and enhance the teaching and learning of mathematics and science by providing technical assistance, linking and coordinating resources, utilizing technology, and disseminating information about successful practices. The goal of the consortium is to empower stakeholders in the Southeast to provide quality mathematics and science programs for all students.

For more information, contact Dr. Francena Cummings, Director, SERVE Mathematics and Science Regional Consortium, 345 S. Magnolia Drive, Suite D-23, Tallahassee, FL 32301-2950; 800-854-0476; 904-922-8533.

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